34. *On a new* Area *of* Upper Cambrian Rocks *in* South Shropshire, *with a* Description *of a new* Fauna. By Charles Callaway, Esq., M.A., B.Sc. Lond., F.G.S. (Read March 21st, 1877.)

[Plate XXIV.]

Introduction.

In March 1874 I communicated to this Society a paper entitled, "On a Tremadoc area near the Wrekin in South Shropshire, with description of a new Fauna," which was published in abstract in the Society's Journal, vol. xxx. p. 196.

In that paper I described certain shales, commonly supposed to be Caradoc, which I had examined at Shineton, two miles S.S.W. of the Wrekin. In these shales I had found *Conocoryphe*, *Lingulella*, and other fossils of a Cambrian* type; and from this and other evidence I had concluded the beds were of Tremadoc age. My views, however, were not accepted by the Fellows present at the reading of my paper, on account of the alleged imperfection of the fossil evidence; and, as I was at the time absent in America, I had no opportunity of defending my position. Since my return home I have collected more abundant and satisfactory evidence, both geological and palæontological, which I venture to think will establish my original conclusions. I have also made out some additional points of interest in the geology of the neighbourhood of the Wrekin.

Previous Information.

Sir R. Murchison has described the area under examination, from the Wrekin on the north-east to the May-Hill Sandstone at Kenley on the south-west, as composed of strata of Caradoc age, the Wrekin itself being an igneous outburst altering the Caradoc sandstone on its flanks into quartzite.

The Geological Survey has followed Murchison, but has included, under the name of "quartzite," certain sandstones in which I have detected fossils in abundance.

In the Journal of this Society (vol. x. p. 62), Messrs. Aveline and Salter describe this area as Caradoc, and Salter gives a list of fossils from (so-called) Lower Caradoc shales at Harnage and Shineton, mixing up Cambrian forms, such as *Olenus*, from Shineton, with Cambro-Silurian genera, such as *Trinucleus*, from Harnage, the shales at Shineton and at Harnage evidently being considered identical.

* I adopt Mr. Hicks's classification of the Cambrian rocks, and the name "Cambro-Silurian" for the groups from the Arenig to the Lower Llandovery inclusive.

Salter, in the 'Geological Magazine' for 1867, refers to the shales at Shineton, which he there regards as "the top of the Llandeilo Flags proper." The same writer seems, in after years, to have been struck with the incongruous association of Cambrian and Cambro-Silurian forms; for, in 'A Catalogue of the Collection of Cambrian and Silurian fossils contained in the Geological Museum of the University of Cambridge,' published in 1873, while describing what he supposes to be a *Triarthrus* from Shineton, he suggests, "it is possible that the locality may include some *Tremadoc* beds." With this exception, geologists have regarded the rocks of the area under consideration as of Caradoc age.

Object of the Paper.

I propose to describe the Lower Palæozoic rocks ranging from near Wellington on the north-east to the May-Hill Sandstone, at Kenley, on the south-west (see map, p. 654). This area is nine miles in length, and two and a quarter miles in its greatest breadth. My description will include an inlier of ancient rocks at Lilleshall, five miles to the north-east of Wellington. I shall pay no attention to rocks newer than the Caradoc, except so far as is necessary for the elucidation of my subject. I shall endeavour to prove that the shales at Shineton are of Tremadoc age, and that a part of the so-called "quartzite" between the shales and the Wrekin represents the Hollybush Sandstone of Malvern. I have also satisfied myself that the so-called "greenstone" of the Wrekin and neighbouring areas is largely composed of bedded rocks; but I defer discussion on this point, and on the quartzites overlying the Wrekin rocks, till I have made further observations.

Lower Caradoc Rocks.

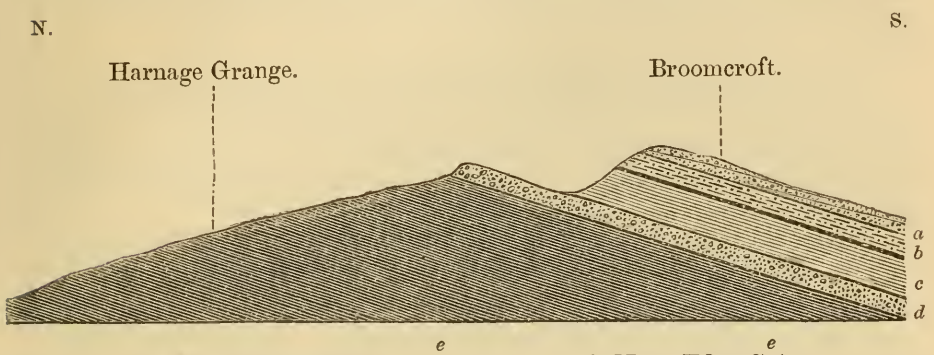
Mr. Salter noticed at Harnage and on Cound Brook certain shales containing *Trinucleus concentricus*, Eaton, *Beyrichia complicata*, Salt., *Diplograpsus pristis*, His., *Orthis testudinaria*, Dalm., and other Cambro-Silurian fossils; and as these shales are very similar in lithological characters to the shales at Shineton, and have the same general strike, both shales were lumped together by him as Lower Caradoc.

After extensive collections of fossils from all parts of the area under consideration, I arrived at the conclusion that in no case were the Shineton and Harnage faunæ intermixed. I also observed that there was a distinct lithological difference between the two shales, the Shineton shales being more fissile, the Harnage shales more conchoidal, in their fracture. I was greatly puzzled, however, at noticing that, in the Cound-Brook and Harnage area, the shales with a Cambro-Silurian fauna were overlain by utterly unconformable Caradoc Sandstone, the unconformability in some cases approaching a right angle. At the same time the shales with the older fauna dipped with apparent conformability under Caradoc sandstone. At last I discovered the following section (fig. 1), which cleared


MAP
OF
UPPER CAMBRIAN ROCKS
NEAR WELLINGTON.
POST-LLANDOVERY
(Wenlock to Tilas.)
POST-LLANDOVERY ROCKS
May Hill Sandstone.
Chatwall Sandstone.
Harnage Shales.
Hoar-Edge Grits
Shineton Shales
Hollybush Sandstone
(?) Cambrian Quartzite
Igneous Rocks
Faults
WILLESHALL
WELLINGTON
WROCKWARDINE
THE ERCALL
THE WREKIN
MADOX'S HILL
WILLOW MOOR
SHINETON
SEVERN
RIVER
LONGWOOD
CRUMPTON
HARNAGE
CRESSAGE
HARLEY
BROMCROFT
COUND
ACTON PIGOTT
ACTON BURNELL
Haughmond Hill
LONGMYND ROCKS
LONGMYND ROCKS

up the difficulty and revealed the true succession. The formations represented are:—the Shineton Shales; the Caradoc, consisting of the Hoar-Edge Grits, the Harnage Shales, and the Chatwall Sandstone; and the May-Hill Sandstone, or Upper Llandovery of Murchison.

Fig. 1.—*Section through Harnage Grange and Broomcroft.*



a. May-Hill Sandstone.
b. Chatwall Sandstone.
c. Harnage Shales.
d. Hoar-Edge Grits.
e. Shineton Shale.

In this section the Shineton Shales and the Caradoc are apparently conformable, and dip at an angle of about 15°. The May-Hill overlies the Caradoc unconformably at a lower angle.

In the road ¾ mile to the west of Harley (see map p. 654) the May-Hill Sandstone rests immediately upon fossiliferous Shineton Shales, both dipping at a very low angle. Half a mile to the west of this locality, a few feet of sandstone with characteristic Caradoc fossils intervene between the shales and the May-Hill; and half a mile to the west of the last locality the section is as above described. Still further to the west and south-west the Caradoc subformations thicken out rapidly. The Hoar-Edge Grits especially, which, in the above section, are represented by sandstone rendered subcalcareous by fossils, acquire great thickness, and form in some parts massive beds of grit. They constitute a ridge ranging from above Harnage Grange, west-south-west, to Shadewell Coppice, where they present a conspicuous feature in the landscape, the increased elevation appearing to correspond with the thickening-out of the beds. To the south-west these beds form the sharp ridge of Hoar Edge. The dip is about 15° in the above section, but becomes steeper to the south-west. The strike is east and west in the ridge above Harnage Grange; but to the south-west it acquires a south-westerly trend. The Hoar-Edge Grits are characterized by *Strophomena expansa*, Sow., *Orthis vespertilio*, Sow., and *O. flabellulum*, Sow.

The grits are succeeded by the Harnage Shales, which are hollowed out into a valley parallel to the ridge made by the grits. The most abundant fossils of these shales, collected near Broomcroft and in the Harnage and Cound-Brook area, are *Trinucleus concentricus*, Eaton, *Beyrichia complicata*, Salt., *Primitia bicornis*, R.

Jones, *Orthis testudinaria*, Dalm., *Theca*, several species of Lamellibranchs, *Diplograpsus pristis*, His., and *Favosites fibrosus*, Goldf. Overlying the Harnage Shales, and forming a ridge parallel to the ridge of the Hoar-Edge Grits, is the Chatwall Sandstone with *Orthis alternata*, Sow.

The May-Hill Sandstone laps round the whole of the older formations from the Shineton Shales to the Chatwall Sandstones, and is clearly unconformable to all, the dip being in every case I have observed lower than the dip of the beds on which it rests.

It will be seen from the above facts that the Hoar-Edge Grits, the Harnage Shales, and the Chatwall Sandstone, all thin out very near together in the area between Stonehouse and Broomcroft, the three subformations succeeding each other in regular order without disturbance beyond their elevation at an angle.

Lower Caradoc Rocks in the Cound-Harnage district.—North of the Shadewell-Coppice ridge, the Hoar-Edge Grits and the Harnage Shales assume characters which are stratigraphically discordant with their relations in the area just described. This discordance is apparently caused by the well-known fault which runs from the Wrekin many miles to the south-west, and in the Harnage district brings the Carboniferous, Permian, and Triassic rocks down against the Caradoc. These lower Caradoc strata cover an area of nearly three miles, from the river Severn on the north-east to Acton-Burnell Park below Shadewell Coppice on the south-west, and $\frac{3}{4}$ mile in their greatest breadth. They are well exposed on Cound Brook where it runs through Evenwood Common, and on the same stream and its easterly branch in the picturesque dells to the south-west of Harnage. The strike of the Harnage Shale is, roughly, north-east, sometimes ranging round to east-north-east. The beds are sometimes nearly vertical; but more frequently they dip at a high angle to the south-east or to the north-west, the north-westerly dips in some cases being as low as 45°. These shales are often very fossiliferous, containing the fauna above described. They are moderately fissile, but less so than the Shineton Shales, of a blue colour, changing to olive near the surface, and often marked with iron-stains, these changes being obviously due to peroxidation of the ferrous oxide.

With the Harnage Shales are associated the Hoar-Edge Grits, which, as in the undisturbed areas, consist of coarse sandstones, sometimes forming conglomerates, and containing a bastard limestone arising from the abundance of fossils. It is not necessary to my present purpose that I should describe these rocks in detail; suffice it to say that, in the dells near Harnage, the Lower Caradoc strata form hills consisting of outliers of low-dipping or horizontal Hoar-Edge Grit resting upon the upturned edges of the Harnage Shales, the older lying unconformably upon the younger. At Acton Pigott, to the south-west, the sandstone constitutes an outlier nearly a mile in length. A portion of this outlier forms a cornice overhanging Cound Brook at Evenwood Common, the lower portion of the banks of the stream consisting of the nearly vertical Harnage Shales. The extraordinary relations of these subformations at

first suggested that the sandstone of Acton Pigott might be Carboniferous. But the discovery in it of *Orthis vespertilio* and *Favosites fibrosus* clearly established its Cambro-Silurian age; and further evidence convinced me that it, as well as the sandstones near Harnage, represented the Hoar-Edge Grits.

This branch of my subject I leave for the present, the chief purpose of my paper being the description of the older rocks of the neighbourhood.

The Shineton Shales.

The locality where I first observed these shales is the spot near Shineton marked on the Geological-Survey Map with an arrow dipping to the south-east at 50°. The rocks are there exposed in two good sections on the left bank of the stream. It is from these sections that most of the characteristic fossils have been obtained; and I have therefore named the formation from this locality.

1. *Area.*—These shales cover an area extending from near Evenwood, on the south-west, to within a mile of Wellington, on the north-east, a distance of eight miles. Their greatest breadth, from Shineton to Dryton, is about two miles; but where they range towards Wellington it is contracted almost to a point. The area is roughly triangular in shape, the apex of the triangle pointing to the north-east. Its north-west side is bounded by a fault or faults for probably its entire length, various formations from the Hollybush Sandstone to the Trias abutting against the shales. On the south-east side, the triangle is covered in by intrusive basaltic rocks for one third of its distance from the apex, and the remainder by the May-Hill Sandstone. The base of the triangular area is limited by the Hoar-Edge Grits. It is not improbable that the Shales will also be found under the Hoar-Edge Grits to the south-west*.

2. *Lithological Characters.*—The Shineton Shales are dark blue, weathering to olive and yellow, the colouring iron-oxide sometimes separating as a stain or film. They are micaceous, thin-bedded, soft, and rather fissile. On the Severn, near Cressage, and at Leighton Mill, my friend the Rev. C. Croft, of Newtown, has detected calcareous nodules; and we have collected similar specimens near the base of the series in a stream below the road $\frac{1}{4}$ mile east of Bank's Lane. At the top of the series, where it passes under Caradoc rocks, the shales become more arenaceous and thicker-bedded, and present the characters of a shore-deposit.

3. *Relations to surrounding Formations.*—Commencing at the apex of our triangular area on the south-east side, the shales are overlain for a distance of nearly two miles by basaltic rocks intruded into the Carboniferous series. For the next five miles to the south-west they are succeeded unconformably by the May-Hill Sandstone. At the base of our triangle they dip with apparent conformity under the Hoar-Edge Grits. The north-west side is probably entirely limited by faults, the formations being brought against the shales

* There is little doubt that the valley between the Lawley hill and Hoar Edge is hollowed out of Shineton Shale.

in the following order, commencing on the south-west :—Harnage Shales, Coal-measures, Quartzite, Hollybush Sandstone, and Millstone Grit. Mr. Croft and myself have detected the Shineton Shales within the disturbed area of the Harnage Shales. In a section of about 100 yards, on Cound Brook, just above Cound-Moor Quarry, we have the following perplexing succession :—

(1). Shineton Shales, dip easterly at 55°.
(2). Harnage Shales, dip N.N.W. at 55°.
(3). Conglomerate, dip unknown.
(4). Shineton Shales, dip unknown.

The beds are so dislocated in this area that I can make out no definite relations between the Shineton Shales and the newer rocks; and I have not attempted to map these fragments of the older series.

4. *Dip and Strike.*—The general strike of the shales is about south-west, agreeing with the direction of the great fault and of the so-called igneous elevations of the district; but towards the south-west end of the area it bends round to the west, corresponding with the strike of the overlying Caradoc. The mean dip of the greater part of the shales is about 30° to the south-east; but in the lower part of the series, where they approach the fault, it becomes higher, then vertical, then dips steeply to the north-west, the evidence pointing towards the existence of an anticlinal. To the south-west, where the beds incline to the south below the Caradoc, the dips are below 30°, averaging 15° to 20°. A few examples will illustrate my statements. At Bull-Hill Cottage, near Evenwood, where an upper branch of Cound Brook cuts through the escarpment of the Hoar-Edge Grits, the grits dipping at 25° rest upon the shales inclined at about the same angle. One mile to the east, above Harnage Grange*, Caradoc at 15° is underlain by shale at 12°. One mile to the east of the last locality, where May-Hill Sandstone lies on the Shineton Shale, both dip at an angle of not more than 6°. Two miles to the north-east, at Shineton, the shales dip at 45° and the May Hill at 10°. Most of these dips and strikes were first taken by the Rev. C. Croft, to whom I am indebted for many valuable suggestions and much effectual assistance, and on whose judgment I can entirely rely; but in the great majority of cases I have confirmed his results by my own observations. A few dips in different parts of the area are discordant with the general strikes, but they are probably due to slight local disturbances. I estimate the thickness of the Shineton Shales at not less than 1500 feet.

5. *Stratigraphical Position.*—The Shineton Shales underlie the May-Hill Sandstone unconformably; they are therefore older than that formation by an interval. They underlie the Caradoc, and are, of course, of greater antiquity. There is no formation which they clearly overlie; they may therefore be of any age anterior to the Caradoc. I shall endeavour to show that they are of Tremadoc age.

* This locality must not be confounded with the village of Harnage, one mile and a half to the north.

(*a*). *Evidence from fossils.*—Most of the Shineton forms are new specifically, and several new generically. The species which are of geological value are the following:—

Conocoryphe monile, Salter.

This species closely resembles *C. striata*, Emmr., which is one of the forms characteristic of Barrande's "Primordial zone," and is truly typical of the genus. *Conocoryphe* proper is common in the Lower Cambrian of St. David's and in the Potsdam Sandstone of North America, but is not characteristic in newer formations in Britain. It is one of the most ancient known forms of life.

Olenus Salteri, Callaway, and *O. triarthrus*, n. sp.

This genus has not hitherto, so far as I am aware, been found above or below the horizon of the Lingula-flags. These two species are not typical *Oleni*, but are allied to some of Angelin's subgenera, possessing characters found in *Leptoplastus*, *Eurycare*, and *Sphærophthalmus*; but they cannot be located with either. Angelin's subgenera are characteristic of his *Regio A*, which, whatever be the exact position to which it is finally assigned, is certainly very low down in the earlier rocks. It is probably representative of our Lingula-flags.

Agnostus dux, n. sp.

A form closely allied to certain Menevian forms of St. David's.

Lingulella Nicholsoni, Call.

Resembling *L. lepis*, Salt., of the Lower and Upper Tremadoc of Portmadoc.

Obolella sabrinæ, Call.

Closely allied to *O. sagittalis*, Salt., of the Menevian of St. David's.

The above fauna has a very ancient facies, and, taken by itself, would suggest an age anterior to the Tremadoc.

Species of *Theca* and *Bellerophon* occur in the shales, and, though not of decisive value, are forms which we should expect to find in Cambrian rocks.

Asaphus (*Asaphellus*) *Homfrayi*, Salt.

An Asaphid with unforked labrum, common in the Upper Tremadoc of Portmadoc, and the only form in the Shineton Shales (except perhaps a hydrozoan or two) which is not new to science.

Asaphus (*Platypeltis*) *Croftii*, Call.

An asaphoid form with entire labrum, but of a different type from *A. Homfrayi*. The typical Asaphids are Cambro-Silurian; but the entire labra connect these two species with the older forms of the family, such as *Niobe*.

The majority of the above species have an older facies than the Tremadoc; but the abundant occurrence of an Upper-Tremadoc form and of another Asaphid points in an opposite direction; and I submit that the facts of the case, so far as the fossils are concerned, will be best satisfied by referring the beds to the age of the Lower Tremadoc.

(*b*). *Evidence from Correlation with rocks in other localities.*

Dictyonema-beds at Pedwardine.—About 25 miles to the south-west of Shineton, there is a small exposure of shales at Pedwardine,

near Brampton Bryan. These have been noticed by Sir Roderick Murchison and other authors, and have been commonly placed in either the Lingula or the Tremadoc series. They occur in the same line of strike as the Shineton Shales, and are close to the same great south-west fault on the same (the south-east) side. They dip at a high angle (about 45°) to the west or west south-west, and are overlain by nearly horizontal May-Hill Sandstone, the relation of the two formations being similar to their relation at Shineton. In lithological character, the Pedwardine beds are undistinguishable from the Shineton Shales; and they contain in abundance a common Shineton fossil, *Lingulella Nicholsoni*. It can scarcely be doubted that the two shales are identical; but, before offering further comment, I will call attention to another locality.

Upper Cambrian of Malvern.—The succession of Cambrian rocks near White-leaved Oak, south of Malvern, in descending order, is as follows:—

1. Light-coloured shales with *Dictyonema sociale*, Salt.
2. Black shales with numerous Olenids.
3. Hollybush Sandstone.

The uppermost group, the *Dictyonema*-shales, has been generally considered the equivalent of the shales at Pedwardine, since it is lithologically identical, and contains abundance of the same *Dictyonema*. I have examined certain specimens from these shales which are in the museum at Malvern College, and in Dr. Grindrod's collection; and I had the satisfaction of identifying them as *Platypeltis Croftii* and *Conophrys salopiensis*, two Trilobites characteristic of the Shineton Shales. These shales are also lithologically identical with those of Shineton, and hold the same relation to the overlying May-Hill Sandstone. They hold a similar relation to the Hollybush Sandstone. I have recently discovered between the Shineton Shales and the Wrekin a band of Hollybush Sandstone, which I shall describe further on. This sandstone occurs below the *Dictyonema*-shales at Malvern with the interposition of the black *Olenus*-shales. The juxtaposition of this sandstone to the shales at Shineton and at Malvern is a strong corroboration of the evidence I have adduced for the identity of the two shales.

A comparison of the three formations at Shineton, Pedwardine, and Malvern is very interesting. The Shineton beds are connected with the Pedwardine shales by lithological resemblance, stratigraphical position, and the occurrence of *Lingulella Nicholsoni*. The Pedwardine rocks are correlated with the Malvern *Dictyonema*-shales by lithological resemblance, stratigraphical position, and the link of *Dictyonema sociale*. The Shineton Shales are *directly* connected with the Malvern beds by lithological resemblance, stratigraphical position, and the occurrence of two species of Trilobites in common—and *indirectly* through their correlation with the Pedwardine shales. I think I may fairly conclude that the *Dictyonema* beds at Pedwardine and Malvern are representatives of the Shineton Shales.

The occurrence of *Dictyonema sociale* in the Shineton Shales at Pedwardine and Malvern furnishes another link in the chain of

palæontological evidence. This species is common at the base of the Lower Tremadoc of North Wales, and helps to connect that formation with the Shineton Shales. Taken by itself, the occurrence of a single species may not be decisive; but when other lines of evidence converge to the same point, this fact is of value.

I have stated that all the species of the Shineton Shales are new but two, *Asaphellus Homfrayi* and *Dictyonema sociale*, and perhaps a hydrozoan. It is strange that the fauna should be thus so nearly unique, if beds of the same age and of similar lithological characters (slates being simply altered shales) had been deposited in the same sea; and that there was a water connexion between the Shineton and Tremadoc areas is evident from the occurrence of two species in common. I would therefore suggest the probability of the Shineton Shales forming beds of passage between the Lingula-flags and the Lower Tremadoc—a probability which is strengthened by the fact that *Dictyonema sociale* occurs in passage-beds in the Tremadoc area.

6. *Distribution of the Fauna.*—The bulk of the fossils have been found high up in the series at Shineton; but *Lingulella Nicholsoni* and *Obolella sabrinæ* occur almost wherever the shales are fossiliferous, ranging down to the base of the series near Dryton, where the rocks begin to assume a north-westerly dip. Graptolites are common north of the Severn, their chief habitat being Mary Dingle, near Garmston, but have not yet been found south of that river on any horizon. Trilobites have rarely been found away from the Shineton section, the exceptions being a single specimen of *Platypeltis Croftii* in Mary Dingle, an undeterminable Trinucleoid form from the same locality, *Conophrys salopiensis* in the arenaceous beds near the top of the series west of Harley, and both *P. Croftii* and *C. salopiensis* from Malvern. *Macrocystella* (a new Cystid) has been detected only at Shineton and on Cound Brook.

7. *Relation to the black Olenus-shales at Malvern.*—In the Shineton area the shales are lithologically homogeneous from top to bottom (except that they grow more arenaceous towards the top), and never put on the aspect of the black shales. The fossils also show no signs of transition into another formation, *Lingulella Nicholsoni* and *Obolella sabrinæ* characterizing the series throughout its entire vertical extent; and none of the forms are found in the black shales, the three Shineton species, *Dictyonema sociale*, *Conophrys salopiensis*, and *Platypeltis Croftii* being found at Malvern only in the light-coloured upper shales. I am therefore disposed to conclude that the Shineton Shales represent only the *Dictyonema*-shales of Malvern, though they have a much greater thickness. There are signs of great unconformity between the Shineton Shales and the Hollybush Sandstone of the Wrekin. In Wenlock Wood, near the Wrekin, the shales dip away in the same direction as the sandstone; but to the south-west, near Bank's Lane, they dip towards the sandstone to the north-west; and to the north-east, under Madox's Hill and near Willow Moor, the sandstone dips away from the shale. It therefore appears probable that the shales are faulted against the sandstone; and if the black shales ever existed in the area, they must

either be thrown down out of sight, or the anticlinal to which I have alluded has not brought them to the surface.

The Hollybush Sandstone.

Forming a continuous band between the Shineton Shales and the quartzite which rests upon the Wrekin, is a series of thin-bedded, micaceous, green sandstones, holding the same geographical relation to the Shineton Shales as the Hollybush Sandstone of Malvern holds to the black *Olenus*-shales. The identification of this rock with the Hollybush Sandstone is placed beyond doubt by the further evidence of *Kutorgina cingulata*, Bill., which occurs in abundance and in good preservation at Neves Castle, at the south-west end of the Wrekin, and has also been detected by me near Lawrence Hill, one of the lower elevations of the Wrekin range, where the sandstone has been excavated for the purpose of erecting an ancient tumulus. At this locality I also found the impression of the thorax of a Trilobite, but too imperfect for even generic identification. The sandstone covers an area three and a half miles in length by half a mile in its greatest breadth, its length running parallel to the axis of the Wrekin. The dips are very various. At the north-east end of the area several exposures give a dip averaging 50° to the west-south-west. Near the road ascending from the Wrekin to the Hatch Kiln the dip is 75° to the north-west. One third of a mile to the south-west of this locality, the sandstones dip south-30°-east at an angle of 55°, apparently resting conformably upon the quartzite which immediately underlies them. In a quarry 250 yards from this, the dip is west-30°-south, at 35°. At the south-west end of the sandstone area, near Neves Castle, are two exposures, one on the north of the road dipping south-south-east at 50°, and one to the south of the road with a dip of 50° to the south-5°-west. This last locality is the quarry in which *Kutorgina cingulata* plentifully occurs. The same dip as the last is seen in a quarry to the south of the road from Neves Castle to Long Wood. The sandstone and the shales are found in almost immediate contact in Back Dingle, to the south-west of Neves Castle; and, south of the road from Neves Castle to Bank's Lane, a stream-section shows the Shineton Shales plunging at an angle of 65° towards the sandstone. I have already (p. 661) given reasons for concluding that the Shineton and the Hollybush are separated by a fault. The irregularity of the dips which I have just described shows also a want of conformity between the sandstone and the quartzites, which dip regularly away from the Wrekin to the south-east. I am obliged to infer that the Hollybush Sandstone in this locality is bounded by faults on both sides.

This sandstone is also found at Lilleshall, five miles to the north-east of the Wrekin, where it constitutes an inlier a mile long by $\frac{1}{4}$ mile wide. It is micaceous, thinly laminated, and of a blackish green colour. It is well exposed in the road through the village, dipping evenly to east-30°-south at 30°. On the south-east it is bounded by the Carboniferous Limestone and the Millstone Grit, on

the north-west by a fault which divides it from rocks similar to those of the Wrekin. The quartzite, which in the Wrekin district intervenes between the sandstone and the central rocks of the axis, is here absent. I have not detected fossils in this area.

Physical Features of the Shineton Area.

The Shineton Shales, as may be imagined from their uniform softness, present few striking inequalities in the landscape; but to the north of the Severn, where small streams have cut deeply into them, the narrow and picturesque ravines called respectively Back Dingle and Mary Dingle are formed. To the south-west of the Wrekin, the Hollybush Sandstone constitutes high ground sloping down towards the shales; but to the north-east of the area, where the Wrekin chain rises into a lower elevation called the Ercal, the sandstone forms a distinct wooded ridge parallel to the axial elevation of the district, and during the north-easterly part of its course is accompanied by a second parallel ridge, caused, I believe, by a repetition by a fault. In the disturbed region on Cound Brook, the outliers of Caradoc sandstone give great variety to the scenery, forming the cappings of low but steep hills separated by narrow gorges excavated in the soft Harnage Shales. The Hoar-Edge Grits also constitute the low ridge on which Acton Pigott is situated. The same sandstone, with the upper arenaceous beds of the Shineton Shales underlying, forms the ridge which limits the area of the Shineton Shales to the south-west, and rises to a bold elevation at Shadewell Coppice, overhanging Acton-Burnell Park. In this same locality the Chatwall Sandstone, partly covered in by the May-Hill Sandstone, makes a ridge running roughly parallel to the Hoar-Edge Grits, the intermediate Harnage Shales being hollowed out into a deep valley.

DESCRIPTION OF THE FAUNA.

Asaphus, *Brongn.*

Asaphellus, nov. subgen.

Asaphus (Asaphellus) Homfrayi, Salter. (Plate XXIV. fig. 1.)

Our Shineton form is undistinguishable from Salter's species. I reproduce part of his description (Mon. Sil. Tril. p. 165, pl. xxiv. figs. 6–12):—

"The head is more than a third of the whole length, and longer than the thorax, which in its turn is longer than the caudal shield. The head is semioval, rather pointed in front, and has very short posterior spines; it is broadly depressed round the margin. The glabellar portion is scarcely marked out; the eyes are placed nearly halfway up the head; they are small (two lines long), the facial sutures curving out boldly beneath them, and cutting the posterior margin more than halfway out from the axis. Above the eye they form a narrow ogive, and nearly follow the front margin. On the

underside of the head the vertical furrow on the epistome shows distinctly through the cast. The labrum is imperfect, but exhibits a strong marginal groove and two small lateral furrows.

"The body-rings have the axis as broad as the sides, and moderately convex. The pleuræ are flat as far as the fulcrum, truncate at their ends, and have but a slight groove, which reaches only two thirds of the length. The fulcrum is at one third in front, and less than halfway out in the middle rings.

"The caudal axis extends three fourths down the smooth tail, very indistinctly marked above, but in some specimens crossed by several faint rings, and is always prominent at the tip.

"This has the characteristic facial suture of *Isotelus*; but if its labrum be like that of *A. affinis* (*i. e.* entire), a point which is not yet known, it may belong to quite a distinct subgenus."

To this account, which very well suits our Shineton forms, I have to add a description of the labrum.

Labrum as broad as long, rounded on all sides, slightly indented in front; centre rather convex, with a strong furrow on each side converging to nearly the front indentation; just below the centre a tubercle on each side, margined by a short deep furrow behind.

The labrum (Pl. XXIV. fig. 1), as Salter inferred from the imperfect material at his command, is not forked, a character which clearly distinguishes this species from typical *Asaphi*; and I propose for it the subgeneric name of *Asaphellus*. Fragments indicate a size of three inches by two. This makes the breadth greater than in Salter's description, "three inches long and one and a half broad;" but the specimens from Portmadoc are so greatly cleaved as to render the measurement of proportions exceedingly difficult.

From the Shineton Shales at Shineton. Very common.

Platypeltis, subgen. nov., *Callaway*.

Platypeltis, Callaway, Quart. Journ. Geol. Soc. vol. xxx. p. 196, 1874.

Oval, moderately convex; axial furrows tapering gradually backwards from where they meet the facial suture in front of the eye to two thirds the length of the tail; head and thorax about equal in length, tail shorter.

Head with short cheek-spines, length two thirds the width; eyes placed near the margin, one third the length of the head, facets small as in typical *Asaphi*; facial suture forming three curves of about equal length, cutting the front margin in front of the eye, and the hinder margin at more than halfway from the axis; glabella one third of the width of the head behind, lobeless, axial furrows well marked; labrum (Pl. XXIV. fig. 2 *a*) entire, broadly rounded in front, closely resembling the labrum of *Asaphellus*, but seemingly destitute of the two furrows which converge from the side tubercles towards the front.

Thorax with well-marked axis equal in breadth to the pleuræ; pleuræ rounded at the ends, faceted, grooved to less than half their

length in front, to two thirds behind, with fulcrum at about one third from the axis.

Tail smooth; axis extending to two thirds the length, faintly marked with transverse furrows; caudal fascia broad, well striated.

This subgenus is distinguished by its large eyes and unforked labrum. The central shield of the head is often found alone; and its peculiar shape is very distinctive. It is worth noting that both the Asaphids of these ancient rocks have the labrum entire.

Asaphus (Platypeltis) Croftii, *Call.* (Plate XXIV. fig. 2.)

Asaphus (*Platypeltis*) *Croftii*, Call. Quart. Journ. Geol. Soc. vol. xxx. p. 196, 1874.

The characters of the genus will suffice for the one species.

From the Shineton Shales at Shineton, where it is common; Mary Dingle, near Garmston; Dictyonema-shales at Malvern (Dr. Grindrod's collection).

Agnostus, *Brongn.*

Agnostus dux, n. sp. (Plate XXIV. fig. 3.)

Head: length and breadth equal, with a narrow margin; glabella half the length of the head, sometimes longer, as broad as the side cheeks behind, narrowing towards the front, with a transverse sulcus one third from the front.

Thorax: axis wide, each of its rings trilobed, the central lobe much wider than the others; pleuræ not much longer than the side lobes of the axis.

Tail same size as the head, with small side angles; axis one half to two thirds the length of the tail, with a large tubercle at each side in front, and a transverse sulcus about halfway down, the triangular space thus enclosed rising into a tubercle.

This species resembles *A. Maccoyi*, Salt., but differs from it in the glabella, which in *A. Maccoyi* has its front division lunate, whereas *A. dux* has the glabella divided transversely by a straight line, in this respect resembling *A. scutalis*, Salt., and some other Menevian forms. The largest specimen I have seen is a little over half an inch.

From the Shineton Shales at Shineton. Not very rare.

Conocoryphe, *Corda.*

Conocoryphe monile, *Salt.* (Plate XXIV. figs. 4, 4*a*, 4*b*.)

Conocoryphe monile, Salt. Cat. Cambr. & Sil. Foss. Univ. Cambr. 1873, p. 32. "Glabella lobed and front marginal furrow dotted."

I add a fuller description of this interesting little species:—

Oval, convex, surface finely granuliferous, length about $\frac{1}{2}$ inch.

Head semicircular; front marginal furrow dotted; cheek-spines long; glabella strongly lobed, almost as in *Calymene*, three fifths the length of the head; facial suture cutting the front margin a little inside the eye and the hinder margin a little inside the head-spines: eye large, placed near the side margin, ocular ridges well marked.

Thorax of 13 rings; axis about $\frac{1}{4}$ the width of the body, each ring rising into a nodule at the sides; pleuræ, fulcrum nearly halfway out, grooved almost to the ends, which are rounded.

Tail small, entire, axis reaching nearly to the margin.

This species closely resembles *C. striata*, Emmr., of Barrande's "Primordial Zone."

From the Shineton Shales at Shineton. Common.

Olenus, *Dalm.*

Olenus Salteri, *Call.* (Plate XXIV. fig. 5.)

(*Conocoryphe*) Quart. Journ. Geol. Soc. vol. xxx. p. 196.

Head wider than body, transversely oval, with short curved spines at two thirds from the front, margined by a narrow furrow; glabella ovate, wider than fixed cheeks, nearly reaching the front margin, with two pairs of lateral furrows; facial suture as far out behind as the ends of the pleuræ, but in front cutting the margin a little outside of the anterior prolongation of the sides of the glabella; eyes forward, submedian, roundish oval, prominent, distinctly showing the facets; occipital ring with a spine or tubercle.

Thorax of 11 (or more) rings, each ring with a tubercle; axis as wide as pleuræ; pleuræ strongly grooved and bent sharply backward into points.

Pygidium small, axis of two or three rings, nearly reaching the margin, which is rounded.

I originally described this as a *Conocoryphe*, from imperfect material.

From the Shineton Shales at Shineton. Common.

Olenus triarthrus, n. sp. (Plate XXIV. fig. 6.)

Head wider than body, transversely oval, with curved spines at two thirds from the front reaching back as far as the tail, margined by a deep dotted furrow; glabella much wider than the fixed cheek, subquadrate, shorter than in *O. Salteri*, with two pairs of lateral furrows, the hinder pair nearly meeting; facial suture nearly as far out as the ends of the pleuræ behind, in front cutting the margin some distance outside the forward prolongation of the sides of the glabella; eyes forward, near the glabella; occipital ring with a tubercle.

Thorax of 15 (or more) rings; axis not so wide as the pleuræ, each ring with a tubercle; pleuræ grooved to the ends, bent back to a point.

Pygidium short, rounded; axis of 2 or 3 rings, reaching nearly to the margin.

This species is easily separated from *O. Salteri* by its squarish glabella, its long cheek-spines, its narrow axis, and its more numerous segments. In its long spines it resembles *Eurycare*, Ang.; but the eyes are not lateral as in that genus. In some points it suggests *Triarthrus*, and is, perhaps, the form which Salter doubtfully assigned to that genus.

From the Shineton Shales at Shineton. Common. I am indebted to my friend, Mr. C. Bird, B.A., of Bradford, for the loan of specimens of this and other species.

These two species are distinguished from *Olenus* proper by their wide, rounded side cheeks, with spines proceeding from the middle, and they are more nearly allied to some of Angelin's subgenera. *O. Salteri* resembles *Leptoplastus*, Ang., in its short head-spines, and *Sphærophthalmus* in its convex, nearly circular eye; while *O. triarthrus* has the long cheek-spines of *Eurycare*, Ang. I am not, however, prepared to suggest a new generic name for Trilobites which are essentially *Oleni*.

Conophrys, *Call.*

Conophrys, Call. Quart. Journ. Geol. Soc. vol. xxx. p. 196.

Very small, not more than $\frac{1}{4}$ inch long, oval, convex.

Head subquadrate, front rounded; glabella three fourths the length of the head, behind as wide as the side cheeks, its sides parallel for two thirds of its length, with two very small lobes on each side deeply separated from the cheeks, abruptly expanding in front into two side nodules, its anterior margin hardly distinguished from the front portion of the head; neck and side cheeks with deep marginal furrow behind; no trace of eyes or facial suture.

Thorax a little longer than the head, of six rings; axis a little wider than the pleuræ in front, rather less than the pleuræ behind, rings nodular at the sides; pleuræ bent down sharply at half their length, for three fourths of their anterior breadth raised above the hinder margin, and separated from it by a narrow sulcus.

Tail about half the length of the thorax, semicircular behind and slightly indented, with a narrow raised margin; axis nearly reaching the margin, of four rings; sides consisting of three rings raised in front; margin, axial rings, and side rings all covered with small tubercles.

This curious little genus is easily distinguished by its peculiar glabella. Its small size at first suggested that it was embryonic; but upwards of 20 specimens in my collection, with others that I have seen, show no signs of transition into any thing different, the characters being remarkably permanent. I am unable with certainty to refer it to any known family.

Conophrys salopiensis, *Call.* (Plate XXIV. fig. 7.)

Same reference as genus.

From the Shineton Shales at Shineton, arenaceous beds west of Harley, Dictyonema-shales at Malvern (Dr. Grindrod's Museum).

Lichapyge, *Call.*

Lichapyge, Call. Quart. Journ. Geol. Soc. vol. xxx. p. 196.

Pygidium minute, semicircular in front, a little longer than broad; axis of three or more rings, convex, sharply defined, rather

rapidly tapering behind, at half the length of the tail contracting to a tip, and continuing as a narrow rib to the extremity; side ribs not sharply separated; front side ribs curved backwards and ending in free points which are parallel to the axis, grooved down the centre almost to the ends; second ribs similar, but bent more abruptly backwards; third ribs united on the rib-like prolongation of the axis into a broad ensiform limb, the anterior half of which is embraced by the other ribs, and is marked by similar grooves parallel to its sides, while the hinder half projects in a broad point, the sides of which form an angle of about 60°.

Length $\frac{1}{8}$ inch.

This tail bears some resemblance to *Paradoxides*, but is more like *Lichas*, yet can hardly be classed with either. The specimen is unique; but I have thought it of sufficient interest for description.

Lichapyge cuspidata, *Call.* (Plate XXIV. fig. 8.)

Same reference.

From the Shineton Shales at Shineton.

Primitia, *R. Jones & Holl.*

I have collected more than one species of this genus at Shineton; but Prof. Rupert Jones, who has been kind enough to examine them for me, is unable to identify them with any known species, and the material at my command is not sufficient for satisfactory description. Messrs. Rupert Jones and Holl figure two *Primitiæ* from Shineton in Ann. Nat. Hist. ser. 4, vol. iii. p. 221, stating that their specimens, which they observed in the Woodwardian Museum, did "not exhibit sufficiently definite characteristics for exact determination."

Theca, *Sow.*

Theca lineata, *Call.* (Plate XXIV. fig. 9.)

Same reference.

Biconvex, length four times the breadth, aperture straight, longitudinally striated, about 25 striæ in its greatest width.

Length about $\frac{3}{8}$ inch.

Shineton Shales at Shineton. Not rare.

Bellerophon, *Montfort.*

Bellerophon shinetonensis, n. sp. (Plate XXIV. fig. 10.)

Rapidly expanding, aperture large, striated transversely, about 5 striæ to the line.

Greatest diameter 7 lines.

Shineton Shales at Shineton. Rare.

Lingulella, *Salter.*

Lingulella Nicholsoni, *Call.* (Plate XXIV. figs. 11, 11 *a*, 11 *b*.)

Same reference.

Ovate, depressed, widest about the middle, two thirds as broad as long, front and sides rounded, beak moderately acuminate, area of ventral valve striated, the striæ parallel to the external slope of the valve, pedicel-groove divided by a narrow ridge down the middle, visceral surface pitted, exterior surface marked by fine concentric lines of growth.

Length 5 lines, width $3\frac{1}{2}$.

This is a larger shell than *L. ferruginea*, Salt.; and its sides are not so parallel. It closely resembles *L. lepis*; but *L. lepis* is wider towards the front, according to Mr. Davidson's figures.

The Shineton Shales at Shineton, Mary Dingle, Dryton, Cressage, Bull-Hill Cottage, west of Harley, under Cound-Moor quarry, and Pedwardine. Common.

Obolella, *Billings.*

Obolella sabrinæ, *Call.* (Plate XXIV. fig. 12.)

Same reference.

Small, not exceeding two lines in length, transversely oval, striated concentrically, posterior margin straight; dorsal valve nearly flat, with a narrow area; ventral valve high, conical, pointed, the beak overhanging the hinder margin, with a distinct false area.

In the interior, the dorsal valve is furnished with a pair of large oval muscular scars near the posterior margin, a pair of smaller near the middle, and a large elevated mesial ridge extending nearly three fourths the length of the valve.

This species bears a close resemblance to *O. sagittalis*, Salt., of the Menevian rocks, but is broader, and has the ventral valve more conical, the median ridge is larger and longer, and the valves are furnished with areas.

I originally described this form, from incomplete materials, under the name of *Metoptoma sabrinæ*, the conical ventral valve closely resembling a patelloid Gasteropod.

The Shineton Shales at Shineton, Mary Dingle, Dryton, Cressage, one mile west of Cressage, west of Harley, under Cound-Moor quarry. Common.

Macrocystella, n. gen.

Calyx subcylindrical, nearly twice as long as its greatest breadth, widest in the middle; composed of about four rows of hexagonal plates, two plates occupying the width, those at the ends smaller than the central ones, each compartment of the hexagon being separated from the others by a strong ridge, and containing smaller radiating ridges.

The calyx is surmounted by a ring of small jointed pinnulæ about one fourth the length of the calyx.

Stem very long, nearly as wide as the base of the calyx at the top, tapering rapidly at first, continued in a long, slender, slightly tapering column which consists of longer rings than the wider end.

The shales have not preserved this peculiar form in sufficient per-

fection for satisfactory determination. It is very crinoid-like in its long, slender stem, and its circle of arms, which, however, appear to be only simple pinnulæ.

Macrocystella Mariæ, n. sp. (Plate XXIV. fig. 13.)

Some of the best specimens were collected by Mr. Bird.

The Shineton Shales at Shineton, and under Cound-Moor quarry. Not rare.

Dendrograptus, *Hall.*

Dendrograptus, sp.

I am not prepared to assign the Shineton specimens to any known species, or to give them a new name; and several graptolithologists to whom I have submitted them differ from each other in their determinations. All are found in Mary Dingle, associated with *Obolella*, *Lingulella*, and *Platypeltis*, on a lower horizon than the bulk of the Shineton fauna.

Dictyonema, *Hall.*

Dictyonema sociale, *Salter.*

Good specimens of this common North-Wales species are found in abundance in the Shineton Shales at Pedwardine and south of Malvern.

Kutorgina, *Billings.*

Kutorgina cingulata, *Bill.*

Kutorgina cingulata, Bill. Geol. Surv. Canada, Pal. Foss. vol. i. pp. 8–10.

This form is found in the Potsdam Sandstone of North America, the probable equivalent of our Lingula-flags, or of a still lower group. The *Obolella Phillipsii*, Hall, of the Hollybush Sandstone of Malvern, is identified by Mr. Davidson with Billings's species. I have collected it in abundance in the Hollybush Sandstone at Neves Castle, at the south-west end of the Wrekin, and have also detected it near Lawrence Hill. The specimens collected will throw some light upon the characters of this comparatively unknown genus; but I defer further discussion until I have obtained more satisfactory material.

SUMMARY OF THE FAUNA.

Crustacea.

Asaphus (Asaphellus) Homfrayi, *Salt.* Shineton Shales.
Asaphus (Platypeltis) Croftii, *Call.*, gen. et sp. Shineton Shales.
Agnostus dux, n. sp. Shineton Shales.
Conocoryphe monile, *Salt.* Shineton Shales.
Olenus Salteri, *Call.* Shineton Shales.
—— triarthrus, n. sp. Shineton Shales.
Conophrys salopiensis, *Call.*, gen. et sp. Shineton Shales.
Lichapyge cuspidata, *Call.*, gen. et sp. Shineton Shales.
Primitia, sp. (more than one). Shineton Shales.

PTEROPODA.

Theca lineata, *Call.* Shineton Shales.

HETEROPODA.

Bellerophon shinetonensis, n. sp. Shineton Shales.

BRACHIOPODA.

Lingulella Nicholsoni, *Call.* Shineton Shales.
Obolella sabrinæ, *Call.* Shineton Shales.
Kutorgina cingulata, *Bill.* Hollybush Sandstone.

ECHINODERMATA.

Macrocystella Mariæ, n. gen. et sp. Shineton Shales.

HYDROZOA.

Dictyonema sociale, *Salt.* Shineton Shales.
Dendrograptus. Shineton Shales.

EXPLANATION OF PLATE XXIV.

Fig. 1. Labrum of *Asaphus* (*Asaphellus*) *Homfrayi*, Salter, App. Ramsay, Geol. N. Wales, Mem. Geol. Surv. vol. iii. p. 311, pl. viii. figs. 11–14, 1866: enlarged.
2. *Asaphus* (*Platypeltis*) *Croftii*, Call.: enlarged. A young specimen, showing seven thoracic segments only. Some specimens have as few as two segments. 2 *a*. Labrum of ditto, enlarged.
3. *Agnostus dux*, n. sp.: enlarged.
4. *Conocoryphe monile*, Salter, Cat. Cambr. Foss. p. 32: enlarged. 4 *a* and 4 *b*. Young forms of ditto, enlarged.
5. *Olenus Salteri*, Call.: enlarged.
6. *O. triarthrus*, n. sp.: enlarged. Drawn from a crushed specimen. The head-spines should be more forward, as in *O. Salteri*.
7. *Conophrys salopiensis*, Call.: enlarged. There should be only six thoracic segments.
8. *Lichapyge cuspidata*, Call. Pygidium only: enlarged.
9. *Theca lineata*, Call.: enlarged. There should be no transverse striæ.
10. *Bellerophon shinetonensis*, n. sp.: enlarged.
11. *Lingulella Nicholsoni*, Call. 11 *a*. Interior of ventral valve. 11 *b*. Enlargement of part of 11 *a*, showing the striated area and mesial ridge of the pedicel-groove.
12. *Obolella sabrinæ*, Call. Interior of dorsal valve: enlarged.
13. *Macrocystella Mariæ*, n. gen. and sp.

DISCUSSION.

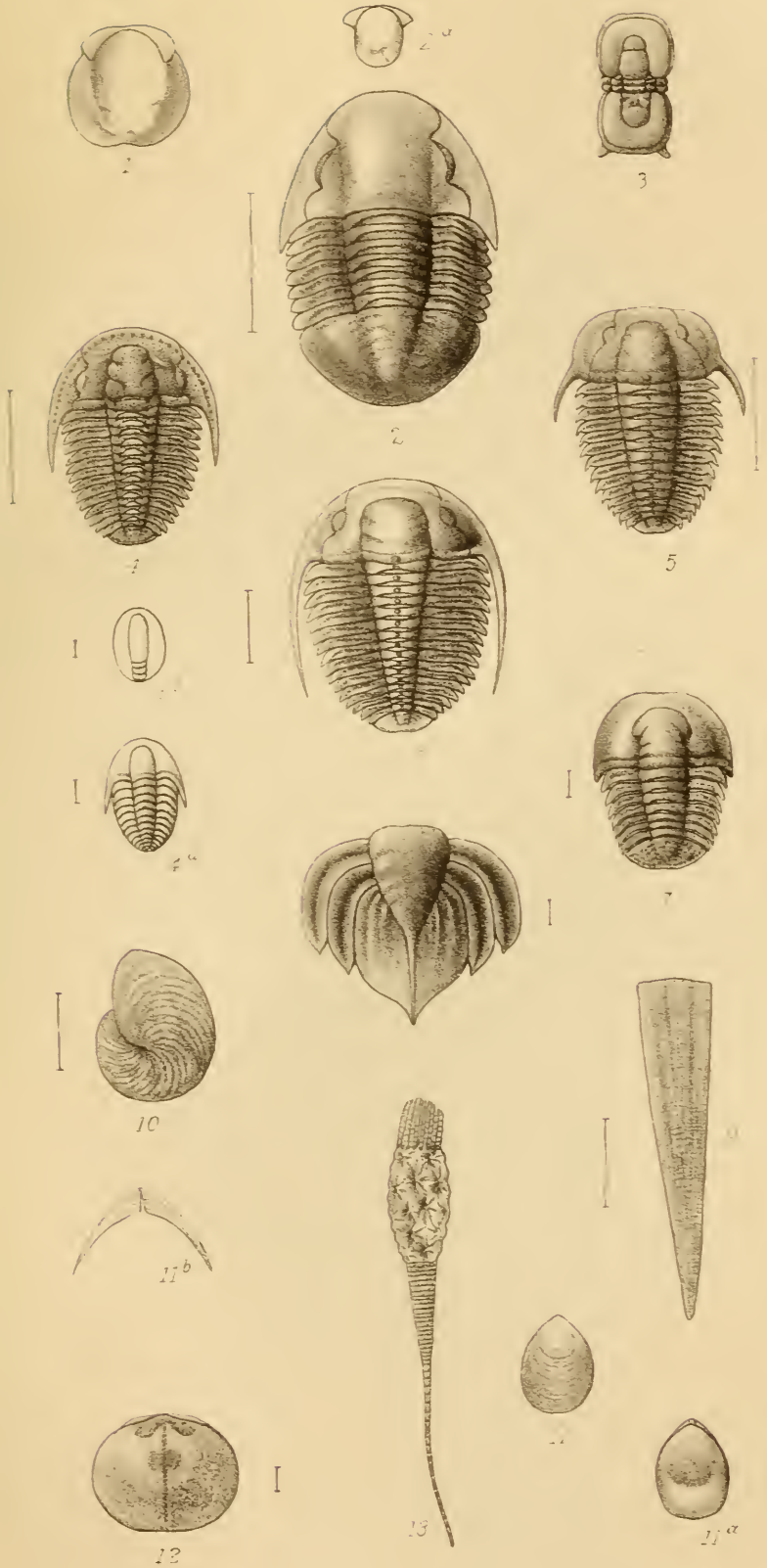
Mr. ETHERIDGE thought the paper a very clear exposition of perfectly new ground. The correlation of the Shineton Shales with the *Dictyonema*-shales of the Malvern hills was important. These labours of Mr. Callaway in a new locality were valuable on account of his palæontological knowledge. The fossils exhibited by him seemed to be distinct species.

Mr. HICKS stated that two years ago he went over part of the Shineton area; and he congratulated Mr. Callaway on the completion of his work over difficult ground. The fossils generally may be regarded as belonging to a Tremadoc fauna; but some seem to belong a little higher in the series, perhaps to the Arenig.

Prof. HUGHES was glad to see the direction in which the author's

inquiries were leading him, as they seemed to point to the fact that when there were no marked changes in lithological character in the Cambrian rocks there was a recurrence or mixture of the forms of life which elsewhere characterized better-defined horizons. He asked the author whether the lower portion of his upper group of grits and shales, with *Orthis testudinaria* &c., might not represent not only Caradoc, but part of the Llandeilo, and whether in the upper part of the lower group the Arenig beds also might not find an equivalent, as he thought it improbable that in that area the Caradoc would be found overlapping Llandeilo and Arenig and resting on Tremadoc.

The Author, in reply to Prof. Hughes, said that the shales were one homogeneous formation, marked throughout by the same fossils, the younger types occurring in the same beds with the older forms, and mixed indiscriminately with them. In the lower part of the upper series, also, there were no signs of transition into an older fauna, the species being common Caradoc forms. In reply to Mr. Hicks, he pointed out that the *Oleni* which, as Mr. Hicks stated, occurred in the Arenig, were of quite a different type from the Shineton *Oleni*, which were antique forms, similar to those in the Dolgelly beds.



C.L.Griesbach lith.

Hanhart imp.

SHINETON FOSSILS.